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AN OVERVIEW OF DEVELOPMENTS IN ROCK MECHANICS IN CANADA - 1983-1987

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MINING RESEARCH LABORATORIES

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AN OVERVIEW OF DEVELOPMENTS IN ROCK MECHANICS IN CANADA' 1983-1987

by

J.E. Udd*

ABSTRACT

Every four years, at the Congresses of the International Society for Rock Mechanics, the regional Vice-Presidents present reports of the developments which have taken place in their areas since the previous Congress.

This report, written by the Chairman of the Canadian national group, has been submitted to the Vice-President for North America for inclusion in the regional presentation.

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Keywords

CARMA, Canadian Rock Mechanics Association, ISRM Congress, Rock Mechanics

SURVOL DES DÉVELOPPEMENTS EN MÉCANIQUE DES ROCHES AU CANADA, 1983-1987

par

J.E. Udd*

RÉSUMÉ

À tous les quatre ans, lors des congrès de la Société Internationale de Mécanique des Roches, les vice-présidents régionaux présentent un rapport sur les développements qui sont survenus dans leur secteur depuis le congrès précécent.

Le présent rapport, écrit par le président du groupe national du Canada, a été soumis au vice-président du secteur Amérique du Nord pour inclusion dans la présentation régionale.

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Mots-Clés

CARMA, Association canadienne de mécanique des roches, congrès SIMR, Mécanique des roches

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INTRODUCTION

The International Society for Rock Mechanics is comprised of national groups located on all six continents. Each year the Society sponsors an International Symposium in one or more of the continental regions and gives its official recognition to other symposia or meetings organized by national groups. Every four years, however, the Society sponsors a premiere event, an international Congress. The sixth of these will be held between August 31 and September 3, 1987, in Montréal, Québec. This is the first time that this magnitude of event, the most important type of international meeting in rock mechanics, will have been held in Canada.

At each of the Congresses the regional Vice-Presidents are required to present comprehensive reports of the developments which have taken place in their respective areas since the previous Congress. Such reports are intended to make the general membership aware of major advances and initiatives that have taken place, or are taking place, throughout the world.

This report, written by the Chairman of the Canadian national group, CARMA (Canadian Rock Mechanics Association), presents an overview of the developments in rock mechanics which have taken place in Canada during the period 1983-1987.

Included in the report are descriptions of:

1) the evolution of the Canadian national group;

2) meetings and symposia organized in Canada during the period;

3) major advances in rock mechanics;

4) national initiatives and trends.

EVOLUTION OF THE CANADIAN NATIONAL GROUP

While practitioners of rock mechanics come from a variety of educational and professional backgrounds, the greatest numbers come from the disciplines of mining and civil engineering.

Rock mechanics came into prominence in the mining engineering profession in Canada during the mid-1950's. The first Canadian Rock Mechanics Symposium was organized by the Department of Mining Engineering and Applied Geophysics (now the Department of Mining and Metallurgical Engineering) of McGill University, Montréal, Québec, in September of 1962. There have now been some 15 symposia in the series.

The original national group, the Canadian National Committee on Rock Mechanics, the CNCRM, represented, for the most-part, the interests of the mining community. In 1983, the CNCRM, with a membership of approximately two hundred, evolved into the Rock Mechanics and Strata Control Committee (RMSCC) of the Canadian Institute of Mining and Metallurgy (CCIM). The change established the group on a more formal basis and brought to it the availability of the full range of services offered by the CIM Secretariat. It also was symbolic of the recognition that rock mechanics had moved from the back rooms of science into the mainstream of mining engineering practice. RMSCC-sponsored sessions at CIM Annual General meetings have been very well attended.

In Civil Engineering the interests of rock mechanics practitioners have been served, for the past generation, by the Canadian Geotechnical Society (CGS). The present rock mechanics community within the CGS also numbers about 200.

With the emergence of this latter organization, it was clear that neither the CGS nor the CIM/RMSCC could be said to represent the total national interests in rock mechanics. The former is comprised mostly of civil engineers while the latter serves the mineral industry community.

Thus, in order to make it possible for Canadian views to be expressed through a single voice a decision was made in the early 1980's to form a single "umbrella" organization. The Canadian Rock Mechanics Association, CARMA, is comprised of the membership of the CIM/RMSCC and the rock mechanics group of the CGS.

CARMA's executive is comprised of the Chair and Vice-Chair groups, plus a Secretary-Treasurer. This year, by invitation, the Past Chairpersons were elected to serve in an ex-officio capacity.

In order to ensure that neither group dominates in representing the Canadian scene, it was agreed that the Chair would alternate between the Chair of the two constituent bodies. Thus, for the next two years, in the writer's capacity as Chair of the CIM/RMSCC he will also serve as the Chair of CARMA. The previous Chairperson was Prof. Branko Ladanyi, representing the CGS. The next Chairperson will also represent that organization.

CARMA represents Canada on the council of the ISRM with either the Chair or a nominee serving. The membership of the national group is presently in the vicinity of about 400.

MEETINGS AND SYMPOSIA IN CANADA DURING 1983-1987

As mentioned previously, since the inception of the Canadian series, in 1962, there have been 15 mining-related rock mechanics symposia held in Canada. During the early years these were held almost annually. With the passage of time,

however, the frequency has been reduced. The reasons lie in the efforts involved in organizing such meetings, in the atmosphere of restraint caused by the economic recession in Canada's mineral industry during the 1980's, and in the feeling that a lesser frequency is more in keeping with the rate at which new technology is being developed.

The last symposium to have been organized by the mining fraternity was held in Sudbury, Ontario, in the autumn of 1983. The theme was Underground Support Systems.

The foregoing is not to imply that there is a lack of interest in Canada in organizing rock mechanics meetings. In practice, quite the reverse is true.

For the past three years the Canadian group has turned its efforts to the major task of organizing the 6th ISRM Congress. Given the size of the Congress and the limited human resources (i.e., volunteers available!) it was decided that a national symposium would not be organized during the period when this otherwise would have taken place (i.e., 1983-1987). The RMSCC has, however, sponsored several technical sessions on rock mechanics topics at each of the Annual General Meetings of the CIM. In May, 1987, in Toronto, for example, some 15 excellent papers were presented in three full half-day sessions. At least the same quantity will be offered at the next AGM, in 1988, in Edmonton, Alberta.

Following the ISRM Congress, a symposium on backfill had been planned for the fall of 1988. At the request of the international organizing committee, however, Canada has converted this meeting from the status of a national symposium to an international one. In order to allow for proper organization the date has been delayed until October, 1989. The meeting, to

be held in the nation's capital, Ottawa, during the first week of October, 1989, will be known as the "4th International Backfill Symposium". The writer of this report has agreed to serve as General Chairman of the meeting.

Similarly, the rock mechanics group within the CGS has also been active. CGS conferences have been held annually, with the locations and themes of the last five having been as follows:

40th Conference, 1987, Winnipeg, "Ground Water Contamination"
39th Conference, 1986, Ottawa, "In-situ testing and field behaviour"
38th Conference, 1985, Edmonton, "Foundations"
37th Conference, 1984, Toronto, "Landslides"
36th Conference, 1983, Vancouver, "Resource Development"

MAJOR ADVANCES IN ROCK MECHANICS

In the view of the writer the major advance that has taken place in rock mechanics in Canada during the past four years is the fact that it has moved into the very mainstream of engineering practice. Today, there is a general awareness of the purpose of the specialization and of what it has to offer. Increasingly, Canadian mining companies are hiring rock mechanics or ground control engineers for location at the mine-sites. Such engineers have the responsibility of reviewing mining plans and tactics, of commenting upon these from a stability point of view, and of advising on the onset of changing or deteriorating conditions. This degree of involvement was exceptional, if not unknown, a decade ago. Increasingly, at the mines, rock mechanics specialists are becoming integrated into the operating team. They are coming to be viewed less and less as staff specialists and more and more as line supervisors in the management chain of command. This is the most positive evidence possible of the recognition on the part of the mining industry on the values to be derived from the practical applications of rock mechanics.

Likewise, on the civil engineering side, the past decade has witnessed the development of a very strong Canadian rock mechanics expertise within both the consulting engineering community and in hydroelectric utilities. Canada has developed skills in the excavation of large caverns, and in mining, in hard rock which are much in demand throughout the world. Many important public utilities, such as British Columbia Hydro, Ontario Hydro, and Hydro Québec, employ large numbers of rock mechanics specialists.

Similarly, governmental departments at both the federal and provincial levels are also developing strong professional groups. It is truly significant that mining inspectorates and provincial departments of labour are also acquiring specialized expertise. There is now a legal requirement in some jurisdictions that the plans and sections for proposed excavations (in

both civil and mining practice) must be reviewed and approved by a rock mechanics engineer prior to the start of the work. This trend is placing tremendous demands on the employment market place since the availability of such persons is very limited.

At the technical level there are perhaps many advances which could be recorded here. Rather than attempting to do so, and running the risk of failing to mention important contributions, the writer prefers simply to summarize the general nature of the technical advances.

In essense, these have been in the development of analytical and design techniques and approaches which have permitted technology to be transferred from the work bench to the work place. Numerical methods of stress analysis and computer software packages have been both highly advanced and well-distributed throughout Canada. Once the exclusive domain of advanced-level professionals, these analytical tools are now generally available to industry either in-house or through the services of consultants. The technology is now advancing so rapidly, as the result of advances in computers and computing systems, that it is likely that very sophisticated methods of analysis and design will be available even to the smallest operations in the not-too-distant future.

NATIONAL INITIATIVES AND TRENDS

An equally, if not more, exciting development, however, is the pattern of mining and geotechnical research which is now emerging in Canada. During the past four years both the breadth and depth of rock mechanics research have been extended greatly. The reason has been in the development of federal/provincial initiatives which have caused greatly increased funding to be made available for rock mechanics research. During the past three years over ten million dollars ($10 M Cdn.) has been committed to Canadian research by the federal and various provincial governments and the mining industry.

The result is that research on a scale never previously attempted in Canada is now in progress. The impact on future technology will be very great.

At the time of writing, the following are in progress:

1) A $4.2 M, 5-year project on rockburst research, is now in the middle of its second year in the Province of Ontario. The project, which is equally funded by the governments of Canada and Ontario and the mining industry of that province has, as one of its objectives, the enhancement of Canadian expertise to a level which is comparable to that elsewhere. This will involve the development of both a national centre of expertise (at CANMET's Elliot Lake Laboratory), and also greatly improved monitoring systems, analytical techniques, and design procedures.

2) In parallel with this, the Government of Canada, through contracts, is expending almost $1 M on the development of two new monitoring systems. The first of these, by INSTANTEL Ltd., of Kanata, Ontario, will be for improved "more-intelligent" in-mine monitoring systems. The second, by the Noranda Research Centre of Noranda Mines Ltd., will be an "out-of-mine" macroseismic system. When completed, these two new systems will complement existing Canadian microseismic systems in several mines. The result will be a vastly improved, and real-time, monitoring capability.

3) A $3.5 M project, focussing on mine backfill, will be completed in the next four years in the Province of Ontario. The project is funded by the Federal Government through a Mineral Development

Agreement with the province. Aspects of the project include: the technology of densified-fills; fill liquefaction; recovery of pillars in tertiary mining, the use of fill to contain violent pillar failure; the use of alternative types of fill; and the development of design technology.

Several of the topics involve field-demonstration trials involving significant parts of underground operations. In one contract, valued at $1 million, with the Ontario Division of INCO Ltd., a whole-mine three-dimensional numerical model is being developed. When completed the model should be in the front rank of any such models in the world.

4) A $1.6 M program in the Province of Manitoba, also through a federal/provincial agreement, for the development of ground control technology which is particularly suited to small mines (often in multi-lensed deposits) in the hard rocks of the Canadian pre-Cambrian shield. The projects include: geotechnical databases; mining method criteria for vertical retreat methods; delayed backfill consolidation; and underground communications systems. The latter has aroused very great interest from our mining industry. This technology, when combined with that to be derived from the rockburst project, should result in new and powerful mine-wide voice and data communications systems having the capabilities of monitoring in real-time.

5) Projects, costing a total of about $200 K, and jointly funded by the federal government (through an MDA) and the potash industry (through the Saskatchewan Potash Producers' Association) are now commencing in the Province of Saskatchewan. One project involves

microseismic monitoring technology while the second involves the development of a subsidence model which is particularly suited to western Canadian potash deposits.

These projects follow after a previous commitment (during the period 1983-1985) of almost $600 K to rock mechanics research in the potash mines of Saskatchewan.

6) In the Atlantic Province of New Brunswick, a project, costing about $400 K, is in place in which a field trial will be used to determine the methods and effectiveness of using waste salt as backfill in potash mines. The objectives are to improve recovery of the mineral and, at the same time, to find a means of solving the environmental problems caused by the storage of waste salt on the surface.

All of the projects mentioned are federal/provincial/industrial initiatives which have been commenced during the past four years. These have all represented additions to the level of rock mechanics research in Canada. The result, today, is that there has been a tremendous growth in this area. From a federal laboratory perspective the result has been a decided change from in-the-laboratory bench-scale work to in-the-mine field-scale work. With the relevance and the applications of the work virtually guaranteed, Canadian rock mechanics will benefit greatly.

Consequently, with the above growth in the overall level of effort, there has also been a decided strengthening of the amount and level of research in academia. Because of the economic recession in the early 1980's, many graduating students continued in universities to pursue studies towards higher degrees. One of the additional benefits of these new major projects that have been mentioned is that these have provided opportunities for the

funding of parts of the academic programs. As well, the value of the involvement of graduate students in significant applied research can not be underestimated.

A major development in the academic sphere is taking place at present. Within the past year, no fewer than three senior-level professional chairs in rock mechanics and ground control have been created in universities in the Province of Ontario. Two of these, at Queen's and Laurentian Universities, were endorsed by the Government of the Province of Ontario, and are cross-appointments at both Universities. The third, at the University of Toronto, has been supported by the National Science and Engineering Research Council of Canada. The result of these new faculty positions will be a strengthened network of rock mechanics and ground control education in the Province of Ontario.

Another significant development in Canada is the creation of research directorates by both the federal and provincial mining associations. Industry now not only accepts the value of research but also is taking an aggressive stance in enhancing its development.

Last year, 1986, the Ontario Mining Association (OMA), formed an organization known as the Mining Research Directorate (MRD). This was followed by the establishment of a Research Committee by the Saskatchewan Potash Producers' Association of Canada (SPPA). In the spring of 1987 the Mining Association of Canada (MAC) formed the Mining Industry Technology Council of Canada (MITEC). The key point is that all of these new organizations have been formed to encourage, aid, and coordinate mining research. The fact that all are directed at the board level by senior executives from the mining industry is an expression of the support which mining research is receiving.

CONCLUSIONS

During the period 1983-1987 there has been a very substantial growth in the support of rock mechanics in Canada. New projects on a very large scale have been implemented in several Canadian provinces. Research in the universities is growing and three new senior-level academic appointments have been authorized in the Province of Ontario within the past year. The mining industry, too, is active through the creation of formal organizations to provide research. All-in-all, the future is very promising.